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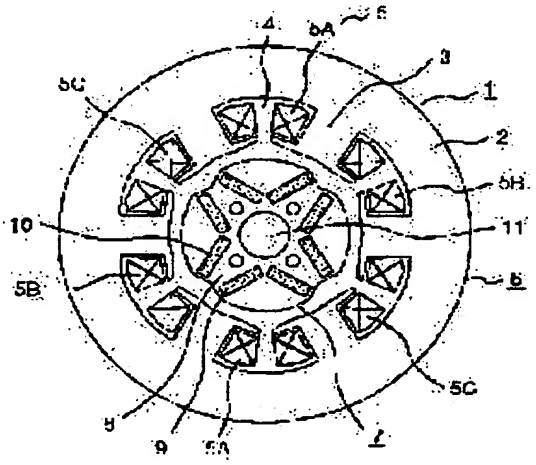
(54) PERMANENT MAGNET TYPE ROTARY ELECTRIC MACHINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a permanent magnet type rotary electric machine which has reduced vibration and noise.
SOLUTION: This permanent magnet type rotary electric machine includes a plurality of permanent magnets embedded in a rotor iron core. The permanent magnets are arranged in a truncated chevron-shape or U-shape for the center of the rotating axial center, the outer circumference of the rotor iron core is formed into a circular shape, an almost V-shape recess is provided at a position between adjacent permanent magnets at the external circumference of a circular shape, an arcuated part and a flat part are provided via a gap at the internal circumferential surface of the head portion of a magnetic pole of the stator iron core which faces to the outer circumference of a circular shape of the rotor iron core, the arcuated part is positioned at the center area dose to the neck part of the magnetic pole of the stator iron core, the rotating axial center of the rotor is arcuated by defining the rotating axial center as the center, the flat part (linear part) is arranged in both sides of the arcuated part, and the gap width from the external circumference of the circular shape is made to widen, as the distance from the arcuated part becomes larger.

図 1



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CLAIMS

[Claim(s)]

[Claim 1] The magnetic pole neck which it is formed so that it may extend in the direction of the inside of the iron core subject section and this iron core subject section, and is looped around an armature winding, The stator core which has the magnetic pole head which turns into a head which it was formed in the tip side of this magnetic pole neck, and was jutted out over the both sides of a magnetic pole neck, In the permanent magnet type dynamo-electric machine which has the rotator prepared free [rotation] inside this stator core, and two or more permanent magnets prepared so that it might lay under the rotor core which forms this rotator The gap prepared between the circular periphery of said rotor core, and the inner skin of said magnetic pole head which meets this circular periphery the permanent magnet type dynamo-electric machine characterized by forming so that it may become the gap width which gets away from said central range to the gap width of about 1 law, and which is alike, follows and spreads gradually in the central range of the place near said magnetic pole neck.

[Claim 2] The magnetic pole neck which it is formed so that it may extend in the direction of the inside of the iron core subject section and this iron core subject section, and is looped around an armature winding, The stator core which has the magnetic pole head which turns into a head which it was formed in the tip side of this magnetic pole neck, and was jutted out over the both sides of a magnetic pole neck, In the permanent magnet type dynamo-electric machine which has the rotator prepared free [rotation] inside this stator core, and two or more permanent magnets prepared so that it might lay under the rotor core which forms this rotator Said permanent magnet is arranged the shape of a Ha character, and in the shape of U character to the core of the revolving-shaft alignment of said rotator. Form the periphery of said rotor core circularly and the crevice of the abbreviation configuration for V characters is established in the place located between said permanent magnets which adjoin this circular periphery. In the inner skin of said magnetic pole head which meets the circular periphery of said rotor core through a gap Prepare the radii section and a flat part and said radii section is located in the central range of the place near said magnetic pole neck. And it is the permanent magnet type dynamo-electric machine characterized by making it gap width with said circular periphery spread as it formed in the radii configuration which makes the revolving-shaft alignment of said rotator the central point, and said flat part was arranged on both sides of said radii section and it got away from said radii section.

[Claim 3] The permanent magnet type dynamo-electric machine characterized by preparing a slit in said rotor core from said permanent magnet at a periphery side in a thing according to claim 1 or 2.

[Claim 4] The permanent magnet type dynamo-electric machine characterized by preparing said two or more slits in a thing according to claim 3.

[Claim 5] The permanent magnet type dynamo-electric machine characterized by said slit forming in the shape of [of Ha] a character to the revolving-shaft alignment of said rotator in a thing according to claim 3 or 4.

[Claim 6] It is the permanent magnet type dynamo-electric machine characterized by being narrower than the tip side width of said magnetic pole neck from which the radii section range width of said stator core becomes the root of said magnetic pole head in any one of the claims 2-5.
[Claim 7] The compressor characterized by making said permanent magnet type dynamo-electric machine into a driving source in any one of the claims 1-6.
[Claim 8] The air conditioner characterized by using said compressor for a refrigerating cycle in a thing according to claim 7.
[Claim 9] The refrigerator characterized by using said compressor for a refrigerating cycle in a thing according to claim 7.
[Claim 10] The freezer characterized by using said compressor for a refrigerating cycle in a thing according to claim 7.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] The concentrated winding of the armature winding is carried out to a stator, and this invention relates to the permanent magnet type dynamo-electric machine which drives compressors, such as an air conditioner, a refrigerator, and a refrigerator, especially about the permanent magnet type dynamo-electric machine with which the rotator is equipped with the rare earth permanent magnet for fields.
[0002]
[Description of the Prior Art] The configuration to a permanent magnet with this kind of various permanent magnet type dynamo-electric machines generally adopted is adopted. For example, in the permanent magnet type dynamo-electric machine given in the re-official announcement patent WO 97/No. 31422 official report, it has the stator to which the armature winding of a concentrated winding was given, and the rotator by which the permanent magnet was dedicated into two or more permanent magnet insertion holes formed in the rotor core so that two or more magnetic pole teeth sections (magnetic pole neck) formed in the stator core may be surrounded, and improvement in effectiveness of a dynamo-electric machine (the so-called improvement in an output) is aimed at using reluctance torque.
[0003] However, while improvement in effectiveness of a dynamo-electric machine could be aimed at by deployment of reluctance torque, it was not taken into consideration about generating of vibration and a noise problem.
[0004] In addition, although the reluctance torque which raises the output of a permanent magnet type dynamo-electric machine is related to the magnitude of the armature reaction magnetic flux generated according to the current supplied to the armature winding, higher-harmonic magnetic flux is also included in this magnetic flux besides fundamental-wave magnetic flux, and since this higher-harmonic magnetic flux serves as pulsating torque which makes a rotator ripple, it results in increasing vibration and the noise on the contrary.
[0005]
[Problem(s) to be Solved by the Invention] When the above-mentioned conventional technique aimed at improvement in effectiveness of a motor, with the rotator structure of the reluctance torque use which adopted especially the concentrated winding, it became clear that the problem of the vibration and the noise by the armature reaction magnetic flux for generating reluctance torque arose.

[0006] This invention is made in view of the above point, and it aims at offering the permanent magnet type dynamo-electric machine which reduced the vibration and the noise by the armature reaction magnetic flux of reluctance torque.

[0007]

[Means for Solving the Problem] In the permanent magnet type dynamo-electric machine which has two or more permanent magnets prepared so that this invention might be laid under the rotor core which forms the rotator prepared free [rotation] inside a stator core, and this rotator The gap prepared between the circular periphery of a rotor core, and the inner skin of the rotor core magnetic pole head which meets this circular periphery in the central range of the place near a rotor core magnetic pole neck, it is characterized by forming so that it may become the gap width which gets away from the central range to the gap width of about 1 law and which is alike, follows and spreads gradually.

[0008] Furthermore, specifically, this invention is as follows.

[0009] This invention is in the permanent magnet type dynamo-electric machine which has the rotator prepared free [rotation] inside a stator core, and two or more permanent magnets prepared so that it might lay under the rotor core which forms this rotator. Said permanent magnet is arranged the shape of a Ha character, and in the shape of U character to the core of a revolving-shaft alignment. Form the periphery of said rotor core circularly and the crevice of the abbreviation configuration for V characters is established in the place located between said permanent magnets which adjoin this circular periphery. In the inner skin of the stator-core magnetic pole head which meets the circular periphery of said rotor core through a gap Prepare the radii section and a flat part and said radii section is located in the central range of the place near a stator-core magnetic pole neck. And it is characterized by making it gap width with said circular periphery spread as it forms in the radii configuration which makes the revolving-shaft alignment of said rotator the central point, and said flat part (bay) is arranged on both sides of said radii section and it gets away from said radii section.

[0010] That is, said gap prepared between a rotor core and a stator core is characterized by being at least two or more kinds of gaps from which width differs.

[0011] Moreover, this invention is characterized by the above-mentioned thing for which the slit was prepared in the rotor core from said permanent magnet in addition at the periphery side.

[0012] Furthermore, this invention is characterized by having formed the above-mentioned slit in the shape of [of Ha] a character, and preparing it two or more pieces.

[0013] This invention is characterized by being narrower than the tip side width of the above-mentioned magnetic pole neck from which the range width of the above-mentioned radii section becomes the root of the above-mentioned magnetic pole head further again.

[0014] Thus, a permanent magnet is arranged the shape of a Ha character, and in the shape of U character to the core of a revolving-shaft alignment. Form the periphery of a rotor core circularly, establish the crevice of the abbreviation configuration for V characters in the place located between said permanent magnets which adjoin this circular periphery, and armature reaction magnetic flux is decreased. In the inner skin of the stator-core magnetic pole head which meets the circular periphery of said rotor core through a gap, the radii section and a flat part (straight-line part) can be prepared, and fluctuation of armature reaction magnetic flux can be further decreased to it. Consequently, by decreasing armature reaction magnetic flux including higher-harmonic magnetic flux, pulsating torque is reduced and a permanent magnet type dynamo-electric machine with little vibration and noise can be offered.

[0015]

[Embodiment of the Invention] Next, with reference to drawing 1 - drawing 6 , the operation gestalt of the permanent magnet type dynamo-electric machine by this invention is explained.

[0016] First, the operation gestalt 1 is described.

[0017] Drawing 1 is the direction sectional view of a path in which showing the operation gestalt 1 of the permanent magnet type dynamo-electric machine by this invention, and having shown the configuration which carried out the cross section of the permanent magnet type dynamo-electric machine in the direction of a path. Drawing 2 is the direction sectional view of a path of a rotator. Drawing 3 is the partial enlarged drawing of drawing 1 , and shows one pole.

[0018] In drawing, the stator core 2 which constitutes the permanent magnet type dynamo-electric machine 1 has the iron core subject section and a magnetic pole. A magnetic pole has the magnetic pole head 17 which turns into a head which it was formed in the tip side of the magnetic pole neck 3 formed so that it may extend in the direction of the inside of the iron core subject section, and this magnetic pole neck 3, and was jutted out over the both sides of the magnetic pole neck 3. A slot 4 is formed in the vena contracta of the magnetic pole neck 3, an armature winding 5 (it consists of a concentrated winding of U

phase-winding 5A, V phase-winding 5B, and W phase-winding 5C) is looped around in two or more of these narrow slots 4, and a stator 6 is constituted.
[0019] A rotator 7 has a circular periphery with a circular periphery. It has a rotor core 8. It has the rare earth permanent magnet 10 (here, four poles showed) by which laying-under-the-ground arrangement was carried out to the revolving-shaft alignment of a rotator 7 all over this rotor core 8 into the permanent magnet insertion hole 9 of V characters (it is the shape of a Ha character to the core of a revolving-shaft alignment) of a convex. A rotator 7 is equipped with the shaft fitting hole 11 for fitting in a shaft (not shown).
[0020] There is a rivet hole 12 for fixing a rotor core 8 to a rotator 7, and in the outer-diameter side of a rotator 7, the width of face of the iron core 13 between poles between the V character configuration rare earth permanent magnets 10 is narrow, and is constituted widely at the bore side. The rotator 7 of the iron core 13 between poles has established the crevice 14 of the abbreviation configuration for V characters in the peripheral face side.
[0021] The radii section 15 (circular part) and a flat part 16 (straight-line part) are formed in said magnetic pole head 3 inner circumference which meets the periphery of a rotator 7.
[0022] Here, it explains in more detail about the radii section 15 (circular part) and a flat part 16 (straight-line part).
[0023] O, both the intersections C and D (root of a magnetic pole head) of the magnetic pole neck 3 and the magnetic pole head 17, and both the intersections of the radii section 15 and a flat part 16 are set to A and B for the revolving-shaft alignment of a rotator 7. the range of the radii section 15 (inside of OA and alumnus segment) -- the inside of OC and OD segment -- the inside -- it constitutes like. Moreover, the radii section 15 is located in the central range of the place near a magnetic pole neck (center of a magnetic pole neck), and is formed a little more narrowly than the tip side width of said magnetic pole neck which becomes the root of a magnetic pole neck. The core of the radii section 15 is the revolving-shaft alignment of a rotator 7.
[0024] Consequently, although it is the gap of fixed width in the radii section 15 (between A-B), the gap formed on the inner circumference (the radii section 15 and flat part 16) of the magnetic pole head 17 and the circular periphery of a rotator 7 consists of places of a flat part 16 so that a gap may spread, immediately after keeping away from the radii section 15 and following. The gap g2 which hits the both-ends side of the magnetic pole head 17, and the gap g1 which hits the radii section 15 serve as relation of $g1<g2$.
[0025] Vibration and the noise of the permanent magnet type dynamo-electric machine 1 are related to the magnet magnetic flux of a permanent magnet 10, and the armature reaction magnetic flux by the armature current. Here, since the concentrated winding is adopted even if it supplies a sine wave to the armature current, harmonic content is contained in gap magnetic flux. Since a reason is a 180-degree coil in the case of the usual distributed winding, armature reaction magnetic flux also serves as a sine wave, but in the case of a concentrated winding, 120 degrees, although it is a coil therefore, the 5th higher-harmonic magnetic flux [7th / 11th / 13th] of ..... besides a fundamental wave occurs in armature reaction magnetic flux. This higher-harmonic magnetic flux turns into pulsating magnetic flux which vibrates a rotator 8, by the pulsating torque generated by pulsating magnetic flux as a result, a rotator 1 vibrates and vibration and the noise of the permanent magnet type dynamo-electric machine 1 increase as a result.
[0026] On the other hand, in this invention, in order to decrease armature reaction magnetic flux, while making a permanent magnet 10 into the V character configuration of a convex to the shaft of a rotator 7, the crevice 14 of the abbreviation configuration for V characters is formed between the poles of the peripheral face of a rotor core 8, and since the iron core 13 between poles is kept away from the magnetic pole neck 3, armature reaction magnetic flux decreases. Furthermore, the radii section 15 and a bay 16 are formed in the inner skin of the magnetic pole neck 3 of a stator core 2, and since it constitutes so that the gap g2 of a flat part 16 may become large from the gap g1 of the radii section 15, armature reaction magnetic flux stops easily being able to pass along the iron core 13 between poles, and decreases armature reaction magnetic flux.
[0027] That is, by decreasing armature reaction magnetic flux including higher-harmonic magnetic flux, pulsating torque is reduced and a permanent magnet type dynamo-electric machine with little vibration and noise can be offered.
[0028] What is necessary is here, for the structure which uses the permanent magnet type dynamo-electric machine 1 just to determine the magnitude of the crevice 14 established in the periphery side of the iron core 13 between poles. Moreover, the range of the radii section 15 is an important factor in order to determine the magnitude of the armature reaction magnetic flux itself. As a result of experimenting in

many things, when the range of the radii section 15 was prepared in OA inside OC and OD segment, and alumnus segment, a result to which vibration and the noise become small was brought. In addition, the case where a structure dimension was determined that q shaft is set as the shaft which goes the direction of magnetic flux of a permanent magnet direct with d shaft and it, and the ratio of Xq/Xd which is the ratio of q shaft reactance Xq and d shaft reactance Xd will become 1.3 or less fulfilled the structure conditions of the dynamo-electric machine 1 when vibration and the noise become small.

[0029] Next, the operation gestalt 2 is described.

[0030] Drawing 4 is the direction sectional view of a path of the rotator of the operation gestalt 2 of the permanent magnet type dynamo-electric machine by this invention. By the rotator in drawing, the same sign is attached about the same thing as what was shown by drawing 1 , and explanation is omitted. A different place from drawing 1 uses a permanent magnet 10 as the permanent magnet 18 of a U character configuration, and the cost of a permanent magnet becomes cheap, and also the effectiveness as the operation gestalt 1 that the fundamental engine performance is the same is acquired.

[0031] Next, the operation gestalt 3 is described.

[0032] Drawing 5 is the direction sectional view of a path of the rotator of the operation gestalt 3 of the permanent magnet type dynamo-electric machine by this invention. By the rotator in drawing, the same sign is attached about the same thing as what was shown by drawing 1 , and explanation is omitted. Differing from drawing 1 is to have formed slits 19 and 20 in the rotor core 8 by the side of the direction of a field (d shaft) by the periphery side of a permanent magnet 10. That is, as a result of being able to decrease armature reaction magnetic flux further also by this, the effectiveness as the operation gestalt 1 that the fundamental engine performance is the same is acquired.

[0033] Next, it spreads about the operation gestalt 4.

[0034] Drawing 6 is the direction sectional view of a path of the rotator of the operation gestalt 4 of the permanent magnet type dynamo-electric machine by this invention. By the rotator in drawing, the same sign is attached about the same thing as what was shown by drawing 4 , and explanation is omitted. Differing from drawing 4 forms slits 19 and 20 in a rotor core 7, and the effectiveness as the operation gestalt 1 that the fundamental engine performance is the same is acquired.

[0035] The permanent magnet type dynamo-electric machine of this invention is used as a driving source of a compressor. Although the compressor is used as driving sources, such as an air conditioner, a refrigerator, or a freezer, since it is working all the year round, it is the maximum important product which attains energy saving from a global warming issue. If the permanent magnet type dynamo-electric machine which adopted the concentrated winding as this driving source is used, energy saving can be attained by efficient-ization of a dynamo-electric machine, but since vibration and the noise become large, adoption is impossible from an environmental problem. However, since vibration and the noise become small and can solve an environmental problem when the permanent magnet type dynamo-electric machine of this invention is made into a driving source, the compressor which can attain energy saving by efficient-ization by the concentrated winding can be offered.

[0036] Although it equips the both sides of the radii section 15 with a flat part 16, if the above-mentioned embodiment fulfills the conditions on which gap width with said circular periphery spreads as it gets away from the radii section, it is changed into a flat part 16 and can carry out [a radii configuration thru/or] a bending configuration.

[0037] In addition, the configuration of a flat part 16 is advantageous in respect of the reinforcement of a magnetic pole head thru/or manufacture etc.

[0038] Moreover, there are various gestalten of a compressor. Although there are methods, such as reciprocating, a rotary, scrolling, and swing, this invention is employable as any compressor.

[0039] Furthermore, if the compressor which made the driving source the permanent magnet type dynamo-electric machine of this invention is adopted as freezers (showcase etc.), the freezer aiming at energy saving can be offered.

[0040]

[Effect of the Invention] As stated above, according to this invention, the permanent magnet type dynamo-electric machine which reduced vibration and the noise can be offered.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the direction cross-section configuration of a path of the permanent magnet type dynamo-electric machine concerning the operation gestalt 1 of this invention.
[Drawing 2] It is drawing which expanded the rotator of drawing 1 .
[Drawing 3] It is the partial enlarged drawing of drawing 1 .
[Drawing 4] It is drawing showing the direction cross-section configuration of a path of the rotator concerning the operation gestalt 2 of this invention.
[Drawing 5] It is drawing showing the direction cross-section configuration of a path of the rotator concerning the operation gestalt 3 of this invention.
[Drawing 6] It is drawing showing the direction cross-section configuration of a path of the rotator concerning the operation gestalt 4 of this invention.
[Description of Notations]
1 -- permanent magnet type dynamo-electric machine, 2 -- stator core, and 3 -- a magnetic pole head, 4 -- slot, 5 -- armature winding, and 6 -- a stator, 7 -- rotator, 8 -- rotor core, and 9 -- a permanent magnet insertion hole, 10 -- permanent magnet, 11 -- shaft fitting hole, and 12 -- a rivet hole, the iron core between 13 -- poles, 14 -- crevice, and 15 -- a circular part, 16 -- flat part, 17 -- magnetic pole head, and 18 -- a permanent magnet, 19 -- slit, and 20 -- slit

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DRAWINGS

[Drawing 1]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号
特開2002－315243
（P2002－315243A）
(43)公開日　平成14年10月25日(2002.10.25)

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			501M	5H605
1/22		1/22	A	5H621
5/24		5/24	Z	5H622
21/14		21/14	G	

審査請求　未請求　請求項の数10　ＯＬ　（全 6 頁）　最終頁に続く

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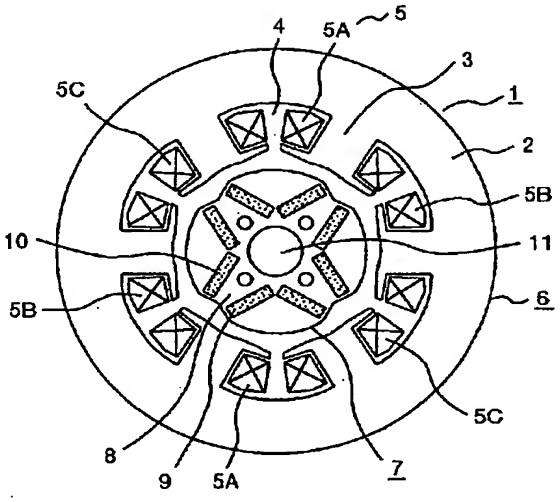
(54)【発明の名称】　永久磁石式回転電機

(57)【要約】
【課題】本発明は、振動・騒音を低減した永久磁石式回転電機を提供することを目的とする。
【解決手段】回転子鉄心に埋設した複数の永久磁石を有する永久磁石式回転電機にあって、前記永久磁石は回転軸心の中心に対してハ字状またはU字状に配置し、前記回転子鉄心の外周を円形に形成し、該円形外周には隣接する前記永久磁石の間に位置するところに略Ｖ字形状の凹部を設け、前記回転子鉄心の円形外周に間隙を介して対面する固定子鉄心磁極頭部の内周面には、円弧部と平坦部を設け、前記円弧部は固定子鉄心磁極首部に近いところの中央範囲に位置させ、かつ前記回転子の回転軸心を中心点とする円弧形状に形成し、前記平坦部（直線部）は前記円弧部の両側に配置させ、かつ前記円弧部から遠のくにしたがい前記円形外周とのギャップ巾が広がるようにしたことを特徴とする。

図　1



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【特許請求の範囲】

【請求項１】鉄心主体部と、該鉄心主体部の内側方向に延在するように形成され、かつ電機子巻線が巻装される磁極首部と，該磁極首部の先端側に形成され、かつ磁極首部の両側に張り出した頭部になる磁極頭部とを有する固定子鉄心と、該固定子鉄心の内側に回転自在に設けられる回転子と、該回転子を形成する回転子鉄心に埋設するように設けた複数の永久磁石とを有する永久磁石式回転電機において、

前記回転子鉄心の円形外周と、該円形外周に対面する前記磁極頭部の内周面との間に設けられる間隙は、前記磁極首部に近いところの中央範囲ではほぼ一定のギャップ巾に、前記中央範囲から遠のくにしたがい次第に広がるギャップ巾になるように形成したことを特徴とする永久磁石式回転電機。

【請求項２】鉄心主体部と、該鉄心主体部の内側方向に延在するように形成され、かつ電機子巻線が巻装される磁極首部と，該磁極首部の先端側に形成され、かつ磁極首部の両側に張り出した頭部になる磁極頭部とを有する固定子鉄心と、該固定子鉄心の内側に回転自在に設けられる回転子と、該回転子を形成する回転子鉄心に埋設するように設けた複数の永久磁石とを有する永久磁石式回転電機において、

前記永久磁石は前記回転子の回転軸心の中心に対してハ字状またはU字状に配置し、前記回転子鉄心の外周を円形に形成し、該円形外周には隣接する前記永久磁石の間に位置するところに略Ｖ字形状の凹部を設け、

前記回転子鉄心の円形外周に間隙を介して対面する前記磁極頭部の内周面には、円弧部と平坦部を設け、前記円弧部は前記磁極首部に近いところの中央範囲に位置させ、かつ前記回転子の回転軸心を中心点とする円弧形状に形成し、前記平坦部は前記円弧部の両側に配置させ、かつ前記円弧部から遠のくにしたがい前記円形外周とのギャップ巾が広がるようにしたことを特徴とする永久磁石式回転電機。

【請求項３】請求項１または２に記載のものにおいて、

前記回転子鉄心には前記永久磁石より外周側にスリットを設けたことを特徴とする永久磁石式回転電機。

【請求項４】請求項３に記載のものにおいて、

前記スリットを２個以上設けたことを特徴とする永久磁石式回転電機。

【請求項５】請求項３または４に記載のものにおいて、

前記スリットが前記回転子の回転軸心に対してハの字状に形成したことを特徴とする永久磁石式回転電機。

【請求項６】請求項２から５のいずれか一つにおいて、

前記固定子鉄心の円弧部範囲巾は、

前記磁極頭部の付け根になる前記磁極首部の先端側巾よりも狭いことを特徴とする永久磁石式回転電機。

【請求項７】請求項１から６のいずれか一つにおいて、

前記永久磁石式回転電機を駆動源としたことを特徴とする圧縮機。

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【請求項８】請求項７に記載のものにおいて、

前記圧縮機を冷凍サイクルに用いたことを特徴とする空気調和機。

【請求項９】請求項７に記載のものにおいて、

前記圧縮機を冷凍サイクルに用いたことを特徴とする冷蔵庫。

【請求項１０】請求項７に記載のものにおいて、

前記圧縮機を冷凍サイクルに用いたことを特徴とする冷凍庫。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、固定子に電機子巻線が集中巻され、回転子に界磁用の希土類永久磁石が備えられている永久磁石式回転電機に関し、特に空気調和機、冷蔵庫および冷凍機等の圧縮機を駆動する永久磁石式回転電機に関するものである。

【０００２】

【従来の技術】一般に採用される、この種の永久磁石式回転電機は，永久磁石に様々な形状が採用されている。例えば再公表特許ＷＯ９７／３１４２２号公報記載の永久磁石式回転電機においては，固定子鉄心に形成された複数の磁極ティース部（磁極首部）を取り囲むように集中巻の電機子巻線が施された固定子と，回転子鉄心に形成された複数の永久磁石挿入孔中に永久磁石が納められた回転子とを有し、リラクタンストルクを利用して回転電機の効率向上（いわゆる出力向上）を図っている。

【０００３】しかしながら、リラクタンストルクの有効利用により回転電機の効率向上が図れる反面，振動・騒音問題の発生については考慮されていなかった。

【０００４】なお、永久磁石式回転電機の出力を向上させるリラクタンストルクは、電機子巻線に供給した電流によって発生する電機子反作用磁束の大きさに関係するが、この磁束には基本波磁束の他に高調波磁束も含まれ、この高調波磁束は回転子を脈動させる脈動トルクとなるため、却って振動・騒音を増大させる結果となるのである。

【０００５】

【発明が解決しようとする課題】上記従来技術は、電動機の効率向上を図っていくと、特に集中巻を採用したリラクタンストルク利用の回転子構造ではリラクタンストルクを発生させるための電機子反作用磁束による振動・騒音の問題が生じることが判明した。

【０００６】本発明は以上の点に鑑みなされたものであり、リラクタンストルクの電機子反作用磁束による振動・騒音を低減した永久磁石式回転電機を提供することを目的とする。

【０００７】

【課題を解決するための手段】本発明は、固定子鉄心の内側に回転自在に設けられる回転子と、該回転子を形成

する回転子鉄心に埋設するように設けた複数の永久磁石とを有する永久磁石式回転電機において、回転子鉄心の円形外周と、該円形外周に対面する回転子鉄心磁極頭部の内周面との間に設けられる間隙は、回転子鉄心磁極首部に近いところの中央範囲ではほぼ一定のギャップ巾に、中央範囲から遠のくにしたがい次第に広がるギャップ巾になるように形成したことを特徴とする。

【０００８】更に具体的には、本発明は次のとおりである。

【０００９】本発明は、固定子鉄心の内側に回転自在に設けられる回転子と、該回転子を形成する回転子鉄心に埋設するように設けた複数の永久磁石とを有する永久磁石式回転電機にあって、前記永久磁石は回転軸心の中心に対してハ字状またはU字状に配置し、前記回転子鉄心の外周を円形に形成し、該円形外周には隣接する前記永久磁石の間に位置するところに略Ｖ字形状の凹部を設け、前記回転子鉄心の円形外周に間隙を介して対面する固定子鉄心磁極頭部の内周面には、円弧部と平坦部を設け、前記円弧部は固定子鉄心磁極首部に近いところの中央範囲に位置させ、かつ前記回転子の回転軸心を中心点とする円弧形状に形成し、前記平坦部（直線部）は前記円弧部の両側に配置させ、かつ前記円弧部から遠のくにしたがい前記円形外周とのギャップ巾が広がるようにしたことを特徴とする。

【００１０】すなわち、回転子鉄心と固定子鉄心との間に設けられる前記間隙は、巾が異なる少なくとも２種類以上のギャップであることを特徴とするものである。

【００１１】また本発明は、上記の加え、回転子鉄心に前記永久磁石より外周側にスリットを設けたことを特徴とするものである。

【００１２】さらに本発明は、上記スリットをハの字状に形成して２個以上設けたことを特徴とするものである。

【００１３】さらにまた本発明は、上記円弧部の範囲巾が上記磁極頭部の付け根になる上記磁極首部の先端側巾よりも狭いことを特徴とするものである。

【００１４】このように永久磁石を回転軸心の中心に対してハ字状またはU字状に配置し、回転子鉄心の外周を円形に形成し、該円形外周には隣接する前記永久磁石の間に位置するところに略Ｖ字形状の凹部を設けて電機子反作用磁束を減少させ、前記回転子鉄心の円形外周に間隙を介して対面する固定子鉄心磁極頭部の内周面には、円弧部と平坦部（直線部分）を設け、電機子反作用磁束の変動をさらに減少させることができる。この結果、高調波磁束を含んだ電機子反作用磁束を減少させることにより脈動トルクを低減して振動・騒音の少ない永久磁石式回転電機を提供できるのである。

【００１５】

【発明の実施の形態】次に，図１～図６を参照して本発明による永久磁石式回転電機の実施形態を説明する。

【００１６】まず、実施形態１について述べる。

【００１７】図１は、本発明による永久磁石式回転電機の実施形態１を示すもので、永久磁石式回転電機を径方向に断面した形状を示した径方向断面図である。図２は回転子の径方向断面図である。図３は図１の部分拡大図で、１極分を示している。

【００１８】図において、永久磁石式回転電機１を構成する固定子鉄心２は、鉄心主体部と磁極を有する。磁極は、鉄心主体部の内側方向に延在するように形成される磁極首部３と，該磁極首部３の先端側に形成され、かつ磁極首部３の両側に張り出した頭部になる磁極頭部１７とを有する。磁極首部３のくびれにスロット４が形成され、このくびれた複数のスロット４内に電機子巻線５（U相巻線５Ａ，Ｖ相巻線５Ｂ，W相巻線５Ｃの集中巻からなる）を巻装して固定子６を構成する。

【００１９】回転子７は外周が円形の円形外周を有する。回転子鉄心８を有する。この回転子鉄心８中に、回転子７の回転軸心に対して凸のＶ字（回転軸心の中心に対してハ字状）の永久磁石挿入孔９中に埋設配置された希土類永久磁石１０（ここでは４極で示した）を有する。回転子７には、シャフト（図示せず）を嵌合するためのシャフト嵌合孔１１が備わる。

【００２０】回転子７には回転子鉄心８を固定するためのリベット孔１２があり、Ｖ字形状希土類永久磁石１０間の極間鉄心１３の幅は、回転子７の外径側に狭く、内径側に広く構成している。極間鉄心１３の回転子７は、外周面側には略Ｖ字形状の凹部１４を設けている。

【００２１】回転子７の外周に対面する前記磁極頭部３内周には、円弧部１５（円弧状部分）と平坦部１６（直線部分）が設けられる。

【００２２】ここで、円弧部１５（円弧状部分）と平坦部１６（直線部分）について更に詳しく説明する。

【００２３】回転子７の回転軸心をＯ、磁極首部３と磁極頭部１７との両交点Ｃ、Ｄ（磁極頭部の付け根）、円弧部１５と平坦部１６の両交点をＡ、Ｂとする。円弧部１５の範囲（ＯＡ，ＯＢ線分内）は、ＯＣ、ＯＤ線分内より内側なるように構成している。また円弧部１５は磁極首部に近いところの中央範囲（磁極首部の中央）に位置し、磁極首部の付け根になる前記磁極首部の先端側巾よりも幾分狭く形成されている。円弧部１５の中心は、回転子７の回転軸心になっている。

【００２４】この結果、磁極頭部１７の内周（円弧部１５と平坦部１６）と回転子７の円形外周とで形成される間隙は、円弧部１５（Ａ―Ｂ間）では一定巾のギャップであるが、平坦部１６のところでは円弧部１５から遠ざかる従い次第ギャップが広がるように構成されている。磁極頭部１７の両端側にあたるギャップｇ２と、円弧部１５にあたるギャップｇ１はｇ１＜ｇ２の関係となっているのである。

【００２５】永久磁石式回転電機１の振動・騒音は永久

磁石１０の磁石磁束と電機子電流による電機子反作用磁束に関係する。ここで、電機子電流に正弦波を供給しても集中巻を採用しているためにギャップ磁束に高調波成分が含まれる。理由は通常の分布巻の場合は１８０度巻線であるために電機子反作用磁束も正弦波となるが、集中巻の場合は１２０度巻線であるが故に電機子反作用磁束に基本波の他、５次、７次、１１次、１３次、……の高調波磁束が発生する。この高調波磁束は回転子８を振動させる脈動磁束となり、結果として脈動磁束によって発生した脈動トルクによって回転子１が振動し、結果として永久磁石式回転電機１の振動・騒音が増大する。

【００２６】これに対し，本発明では電機子反作用磁束を減少させるため、永久磁石１０を回転子７の軸に対して凸のＶ字形状とするとともに、回転子鉄心８の外周面の極間に略Ｖ字形状の凹部１４を形成し、極間鉄心１３を磁極首部３から遠ざけているため電機子反作用磁束が減少する。さらに、固定子鉄心２の磁極首部３の内周面に円弧部１５と直線部１６とを設け、円弧部１５のギャップｇ１より平坦部１６のギャップｇ２が大きくなるように構成しているため、電機子反作用磁束が極間鉄心１３を通り難くなり、電機子反作用磁束を減少する。

【００２７】すなわち、高調波磁束を含んだ電機子反作用磁束を減少させることにより脈動トルクを低減して振動・騒音の少ない永久磁石式回転電機を提供できる。

【００２８】ここで、極間鉄心１３の外周側に設けた凹部１４の大きさは永久磁石式回転電機１を使用する構造体によって決定すれば良い。また、円弧部１５の範囲は電機子反作用磁束そのものの大きさを決定するため、重要な因子である。種々実験を行った結果、ＯＣ、ＯＤ線分より内側のＯＡ、ＯＢ線分内に円弧部１５の範囲を設けた時に振動・騒音が小さくなる結果となった。なお、振動・騒音が小さくなった時の回転電機１の構造条件を満たしたのは、永久磁石の磁束方向をｄ軸、それと直行する軸をｑ軸とし、ｑ軸リアクタンスＸｑとｄ軸リアクタンスＸｄの比であるＸｑ／Ｘｄの比が１．３以下になるように構造寸法を決定した場合であった。

【００２９】次に実施形態２について述べる。

【００３０】図４は、本発明による永久磁石式回転電機の実施形態２の回転子の径方向断面図である。図中における回転子で、図１で示したものと同一のものについては同一符号を付して説明を省略する。図１と異なるところは、永久磁石１０をＵ字形状の永久磁石１８にしたものであり、永久磁石のコストが安くなる他、基本的性能は実施形態１と同様の効果が得られる。

【００３１】次に実施形態３について述べる。

【００３２】図５は，本発明による永久磁石式回転電機の実施形態３の回転子の径方向断面図である。図中における回転子で、図１で示したものと同一のものについては同一符号を付して説明を省略する。図１と異なるのは，永久磁石１０の外周側で磁界方向（ｄ軸）側の回転子鉄心８にスリット１９，２０を設けたことにある。すなわち，これによっても電機子反作用磁束をさらに減少できる結果，基本的性能は実施形態１と同様の効果が得られる。

【００３３】次に実施形態４について延べる。

【００３４】図６は，本発明による永久磁石式回転電機の実施形態４の回転子の径方向断面図である。図中における回転子で、図４で示したものと同一のものについては同一符号を付して説明を省略する。図４と異なるのは、回転子鉄心７にスリット１９、２０を設けたものであり、基本的性能は実施形態１と同様の効果が得られる。

【００３５】本発明の永久磁石式回転電機は、圧縮機の駆動源として用いる。圧縮機は空気調和機、冷蔵庫あるいは冷凍庫等の駆動源として用いられているが、一年中稼動しているため、地球温暖化問題から省エネルギー化を図る最重要製品である。この駆動源に集中巻を採用した永久磁石式回転電機を使用すると回転電機の高効率化によって省エネルギー化を図れるが、振動・騒音が大きくなるので環境問題から採用ができない。しかし、本発明の永久磁石式回転電機を駆動源とした場合、振動・騒音が小さくなって環境問題を解消できるので、集中巻による高効率化で省エネルギー化が図れる圧縮機を提供できる。

【００３６】上記の実施態様は、円弧部１５の両側に平坦部１６を備えたものであるが、円弧部から遠のくにしたがい前記円形外周とのギャップ巾が広がる条件を満たすなら、平坦部１６に変えて円弧形状ないし、折り曲げ形状することが可能である。

【００３７】なお、平坦部１６の構成が磁極頭部の強度面ないし製造面等で有利である。

【００３８】また圧縮機の形態は種々ある。レシプロ、ロータリ、スクロール、スイング等の方式があるが、何れの圧縮機にも本発明は採用可能である。

【００３９】さらに、本発明の永久磁石式回転電機を駆動源にした圧縮機を冷凍庫（ショウケース等）に採用すれば，省エネルギー化を図った冷凍庫を提供できる。

【００４０】

【発明の効果】以上述べたように本発明によれば、振動・騒音を低減した永久磁石式回転電機を提供できる。

【図面の簡単な説明】

【図１】本発明の実施形態１に係る永久磁石式回転電機の径方向断面形状を示す図である。

【図２】図１の回転子を拡大した図である。

【図３】図１の部分拡大図である。

【図４】本発明の実施形態２に係る回転子の径方向断面形状を示す図である。

【図５】本発明の実施形態３に係る回転子の径方向断面形状を示す図である。

【図６】本発明の実施形態４に係る回転子の径方向断面

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形状を示す図である。

【符号の説明】

１…永久磁石式回転電機、２…固定子鉄心、３…磁極頭部、４…スロット、５…電機子巻線、６…固定子、７…回転子、８…回転子鉄心、９…永久磁石挿入孔、１０…＊永久磁石、１１…シャフト嵌合孔、１２…リベット孔、１３…極間鉄心、１４…凹部、１５…円弧状部分、１６…平坦部、１７…磁極頭部、１８…永久磁石、１９…スリット、２０…スリット。

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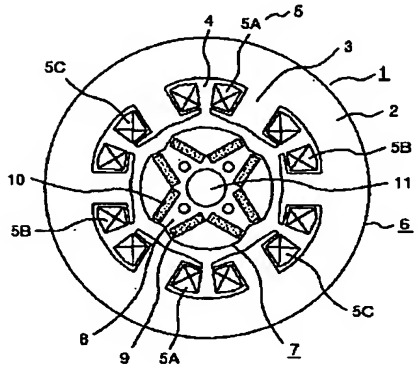
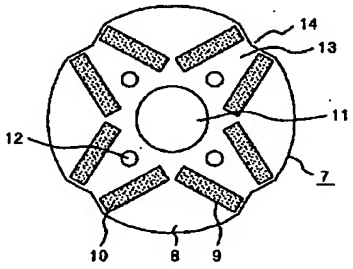
【図１】

図 1



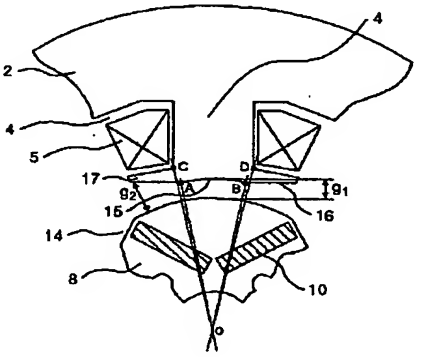
【図２】

図 2



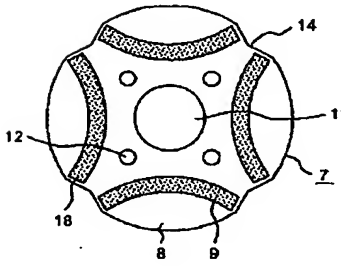
【図３】

図 3



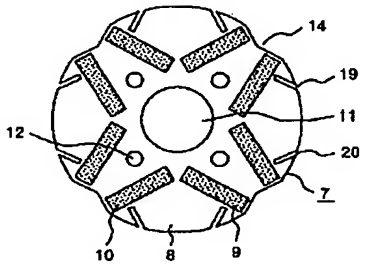
【図４】

図 4



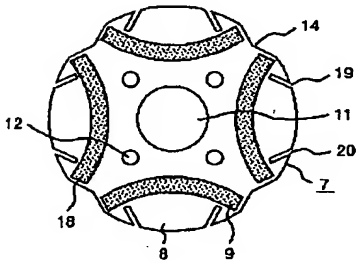
【図５】

図 5



【図６】

図 6



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